Median annual earnings of food batchmakers were $20,990 in 2000. The middle 50 percent earned between $15,980 and $27,600. The highest 10 percent earned more than $33,660, and the lowest 10 percent earned less than $13,250. Median annual earnings in the industries employing the largest numbers of food batchmakers in 2000 are shown below:

Bakery products	$24,660
Preserved fruits and vegetables	21,070
Sugar and confectionary products	20,510
Meat products	20,100
Miscellaneous food and kindred products	19,170

In 2000, median annual earnings for slaughterers and meatpackers were $19,410. The middle 50 percent earned between $16,620 and $21,790. The highest 10 percent earned more than $24,690, and the lowest 10 percent earned less than $14,690. Median annual earnings in meat products, the industry employing the largest number of slaughters and meatpackers, were $19,460 in 2000.

Median annual earnings for food cooking machine operators and tenders were $20,630 in 2000. The middle 50 percent earned between $16,000 and $26,750. The highest 10 percent earned more than $32,780 and the lowest 10 percent earned less than $13,420. Median annual earnings in preserved fruits and vegetables, the industry employing the largest number of food cooking machine operators and tenders, were $21,700 in 2000.

In 2000, median annual earnings for food and tobacco roasting, baking, and drying machine operators and tenders were $22,690, and for all other food processing workers, $18,170.

Food processing workers generally received typical benefits, including pension plans for union members or those employed by grocery stores. However, poultry workers rarely earned substantial benefits. In 2000, more than a third of all butchers and meatcutters were union members or covered by a union contract. Fifteen percent of all bakers and 19 percent of all food batchmakers also were union members or were covered by a union contract. Many food processing workers are members of the United Food and Commercial Workers International Union.

Related Occupations

Food processing workers must be skilled at both hand- and machine-work and must have some knowledge of processes and techniques involved in handling and preparing food. Other occupations that require similar skills and knowledge include chefs, cooks, and food preparation workers.

Sources of Additional Information

Information about work opportunities can be obtained from local employers or local offices of the State employment service. For information on training and other aspects of this trade, contact:

➤ United Food and Commercial Workers International Union, 1775 K St. NW., Washington, DC 20006.

Metal Workers and Plastic Workers

Computer-Control Programmers and Operators

(O*NET 51-4011.01, 51-4012.00)

Significant Points

- Workers learn in apprenticeship programs, informally on the job, and in secondary, vocational, or postsecondary schools; many entrants have previously worked as machinists or machine setters, operators, and tenders.
- Job opportunities will be excellent, as employers are expected to continue to have difficulty finding qualified workers.

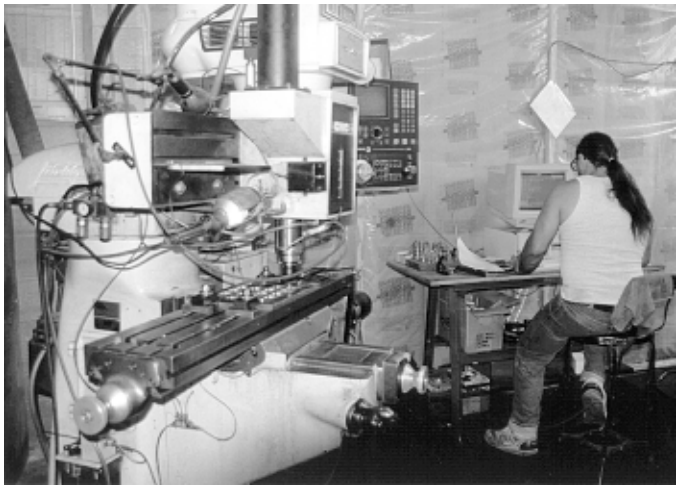
Nature of the Work

Computer-control programmers and operators use computer numerically controlled (CNC) machines to cut and shape precision products, such as automobile parts, machine parts, and compressors. CNC machines include metal-machining tools such as lathes, multi-axis spindles, and milling machines, but the functions formerly performed by human operators are performed by a computer-control module. CNC machines cut away material from a solid block of metal, plastic, or glass—known as a workpiece—to form a finished part. Computer-control programmers and operators normally produce large quantities of one part, although they may produce small batches or one-of-a-kind items. They use their knowledge of the working properties of metals and their skill with CNC programming to design and carry out the operations needed to make machined products that meet precise specifications.

Before CNC programmers—also referred to as numerical tool and process control programmers—machine a part, they must carefully plan and prepare the operation. First, these workers review three-dimensional computerized engineering diagrams (blueprints) of the part. Next, they calculate where to cut or bore into the workpiece, how fast to feed the metal into the machine, and how much metal to remove. They then select tools and materials for the job and plan the sequence of cutting and finishing operations.

Next, computer-control programmers turn the planned machining operations into a set of instructions. These instructions are translated into a computer program containing a set of commands for the machine to follow. The program is then saved onto a computer, which functions as a server. Computer-control programmers and operators check new programs to ensure that the machinery will function properly and that the output will meet specifications. Because a problem with the program could damage costly machinery and cutting tools, computer simulations may be used to check the program instead of a trial run. If errors are found, the program must be changed and retested until the problem is resolved. In addition, growing connectivity between computer-aided design (CAD) software and CNC machine tools is raising productivity by automatically translating designs into instructions for the computer controller on the machine tool. These new computer-automated manufacturing (CAM) technologies enable programs to be easily modified for use on other jobs with similar specifications, thereby reducing time and effort.

After the programming work is completed, computer-controlled machine tool operators, metal and plastic (CNC operators), perform the necessary machining operations. The CNC operators transfer



Computer-control programmers and operators use CNC machines to cut and shape precision products.

the commands from the server to the CNC control module using a computer network link. Many advanced control modules are conversational, meaning they ask the operator a series of questions about the nature of the task. Computer-control operators position the metal stock on the CNC machine tool—spindle, lathe, milling machine, or other—set the controls, and let the computer make the cuts. Heavier objects may be loaded with the assistance of other workers, a crane, or a forklift. During the machining process, computer-control operators constantly monitor the readouts from the CNC control module, checking to see if any problems exist. Machine tools have unique characteristics, which can be problematic. During a machining operation, the operator modifies the cutting program to account for any problems encountered. Unique, modified CNC programs are saved for every different machine that performs a task.

CNC operators detect some problems by listening for specific sounds—for example, a dull cutting tool or excessive vibration. Dull cutting tools are removed and replaced. Machine tools rotate at high speeds, which can create problems with harmonic vibrations in the workpiece. Vibrations cause the machine tools to make minor cutting errors, hurting the quality of the product. Computer-control operators listen for vibrations and then adjust the cutting speed to compensate. In older, slower machine tools, the cutting speed would be reduced to eliminate the vibrations, but the amount of time needed to finish the product would increase as a result. In newer, high-speed CNC machines, increasing the cutting speed normally eliminates the vibrations and reduces production time. CNC operators also ensure that the workpiece is being properly lubricated and cooled, because the machining of metal products generates a significant amount of heat.

Working Conditions

Most machine shops are clean, well lit, and ventilated. Many computer-controlled machines are totally enclosed, minimizing the exposure of workers to noise, dust, and the lubricants used to cool workpieces during machining. Nevertheless, working around high-speed machine tools presents certain dangers, and workers must follow safety precautions. Computer-controlled machine tool operators, metal and plastic, wear protective equipment such as safety glasses to shield against bits of flying metal and earplugs to dampen machinery noise. They also must exercise caution when handling hazardous coolants and lubricants. The job requires stamina because operators stand most of the day and, at times, may need to lift moderately heavy workpieces.

Numerical tool and process control programmers work in offices that typically are near, but separate from, the shop floor. These work areas usually are clean, well lit, and free of machine noise. Numerical tool and process control programmers occasionally need to enter the shop floor to monitor CNC machining operations. On the shop floor, CNC programmers encounter the same hazards and exercise the same safety precautions as CNC operators.

Most computer-control programmers and operators work a 40-hour week. CNC operators increasingly work evening and weekend shifts as companies justify investments in more expensive machinery by extending hours of operation. Overtime is common during peak production periods.

Employment

Computer-control programmers and operators held about 186,000 jobs in 2000, mostly working in small machining shops or in manufacturing firms that produce durable goods, such as metalworking and industrial machinery, aircraft, or motor vehicles. Although computer-control programmers and operators work in all parts of the country, jobs are most plentiful in the Northeast, Midwest, and West, where manufacturing is concentrated.

Training, Other Qualifications, and Advancement

Computer-control programmers and operators train in various ways—in apprenticeship programs, informally on the job, and in secondary, vocational, or postsecondary schools. Due to a shortage of qualified applicants, many employers teach introductory courses, which provide a basic understanding of metalworking machines, safety, and blueprint reading. A basic knowledge of computers and electronics also is helpful. Experience with machine tools is extremely important. In fact, many entrants to these occupations have previously worked as machinists or machine setters, operators, and tenders. Persons interested in becoming computer-control programmers or operators should be mechanically inclined and able to work independently and do highly accurate work.

High school or vocational school courses in mathematics, blueprint reading, computer programming, metalworking, and drafting are recommended. Apprenticeship programs consist of shop training and related classroom instruction. In shop training, apprentices learn filing, handtapping, and dowel fitting, as well as the operation of various machine tools. Classroom instruction includes math, physics, programming, blueprint reading, CAD software, safety, and shop practices. Skilled computer-control programmers and operators need an understanding of the machining process, including the complex physics that occur at the cutting point. Thus, most training programs teach CNC operators and programmers to perform operations on manual machines prior to operating CNC machines. A growing number of computer-control programmers and operators receive most of their formal training from community or technical colleges. Less skilled CNC operators may have only 12 weeks of classroom training prior to working on the shop floor.

To boost the skill level of all metalworkers and to create a more uniform standard of competency, a number of training facilities and colleges have recently begun implementing curriculums incorporating national skills standards developed by the National Institute of Metalworking Skills (NIMS). After completing such a curriculum and passing a performance requirement and written exam, a NIMS credential is granted to trainees, providing formal recognition of competency in a metalworking field. Completion of a formal certification program provides expanded career opportunities.

Qualifications for computer-control programmers vary widely depending upon the complexity of the job. Employers often prefer skilled machinists or those with technical school training. For some specialized types of programming, such as that needed to produce complex parts for the aerospace or shipbuilding industries, employers may prefer individuals with a degree in engineering.

For those entering CNC programming directly, a basic knowledge of computers and electronics is necessary, and experience with machine tools is extremely helpful. Classroom training includes an introduction to computer numerical control, the basics of programming, and more complex topics, such as computer-aided manufacturing. Trainees start writing simple programs under the direction of an experienced programmer. Although machinery manufacturers are trying to standardize programming languages, there are numerous languages in use. Because of this, computer-control programmers and operators should be able to learn new programming languages.

As new automation is introduced, computer-control programmers and operators normally receive additional training to update their skills. This training usually is provided by a representative of the equipment manufacturer or a local technical school. Many employers offer tuition reimbursement for job-related courses.

Computer-control programmers and operators can advance in several ways. Experienced CNC operators may become CNC programmers, and some are promoted to supervisory or administrative positions in their firms. A few open their own shops.

Job Outlook

Computer-control programmers and operators should have excellent job opportunities. Due to the limited number of people entering training programs, employers are expected to continue to have difficulty finding workers with the necessary skills and knowledge. Employment of computer-control programmers and operators is projected to grow about as fast as the average for all occupations through 2010. Job growth will be driven by the increasing use of CNC machine tools, but advances in CNC machine tool technology will further simplify minor adjustments, enabling machinists and tool and die makers to perform tasks that previously required computer-control operators. In addition, the demand for computer-control programmers will be negatively affected by the increasing use of software that automatically translates part and product designs into CNC machine tool instructions.

Employment levels of computer-control programmers and operators are influenced by economic cycles—as the demand for machined goods falls, programmers and operators involved in production may be laid off or forced to work fewer hours.

Earnings

Median hourly earnings of computer-controlled machine tool operators, metal and plastic, were about $13.17 in 2000. The middle 50 percent earned between $10.48 and $16.55. The lowest 10 percent earned less than $8.80, whereas the top 10 percent earned more than $20.25. Median hourly earnings in the manufacturing industries employing the largest number of computer-controlled machine tool operators, metal and plastic, in 2000 were:

Metalworking machinery	$15.20
General industrial machinery	15.06
Industrial machinery, not elsewhere classified	13.05
Motor vehicles and equipment	12.05
Miscellaneous plastics products, not elsewhere classified	11.35

Median hourly earnings of numerical tool and process control programmers were $17.70 in 2000. The middle 50 percent earned between $13.81 and $21.74. The lowest 10 percent earned less than $10.39, while the top 10 percent earned more than $26.66.

Related Occupations

Occupations most closely related to computer-control programmers and operators are other metal worker occupations. These include machinists; tool and die makers; machine setters, operators, and tenders—metal and plastic; and welding, soldering, and brazing workers.

Numerical tool and process control programmers apply their knowledge of machining operations, metals, blueprints, and machine programming to write programs that run machine tools. Computer programmers also write detailed programs to meet precise specifications.

Sources of Additional Information

For general information about computer-control programmers and operators, contact:

➤ Precision Machine Products Association, 6700 West Snowville Rd., Brecksville, OH 44141-3292. Internet: **http://www.pmpa.org**

For a list of training centers and apprenticeship programs, contact:

➤ National Tooling and Metalworking Association, 9300 Livingston Rd., Fort Washington, MD 20744. Internet: **http://www.ntma.org**

For general occupational information, including a list of training programs, contact:

➤ PMA Educational Foundation, 6363 Oak Tree Blvd., Independence, OH 44131-2500. Internet: **http://www.pmaef.org**

Machinists

(O*NET 51-4041.00)

Significant Points

- Machinists learn in apprenticeship programs, informally on the job, and in high schools, vocational schools, or community or technical colleges.
- Many entrants previously have worked as machine setters, operators, or tenders.
- Job opportunities are expected to be excellent.

Nature of the Work

Machinists use machine tools, such as lathes, milling machines, and spindles, to produce precision metal parts. Although they may produce large quantities of one part, precision machinists often produce small batches or one-of-a-kind items. They use their knowledge of the working properties of metals and their skill with machine tools to plan and carry out the operations needed to make machined products that meet precise specifications.

Before they machine a part, machinists must carefully plan and prepare the operation. These workers first review blueprints or written specifications for a job. Next, they calculate where to cut or bore into the workpiece (the piece of metal that is being shaped), how fast to feed the metal into the machine, and how much metal to remove. They then select tools and materials for the job, plan the sequence of cutting and finishing operations, and mark the metal stock to show where cuts should be made.

After this layout work is completed, machinists perform the necessary machining operations. They position the metal stock on the machine tool—spindle, drill press, lathe, milling machine, or other—set the controls, and make the cuts. During the machining process,